

Procedures and Guidelines

DIRECTIVE NO. 303-PG-7120.2.1A
EFFECTIVE DATE: July 27, 2004
EXPIRATION DATE: July 27, 2009

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Responsible Office: Code 303 / Assurance Management Office

Title: Procedure for Developing and Implementing Software Quality Programs

PREFACE

P.1 PURPOSE

This procedure provides direction to Software Quality (SQ) personnel responsible for developing and implementing Software Quality programs for all GSFC developed or acquired software products and systems. Additional work instructions provide applicable procedures, step-by-step instructions, and checklists for performing SQ process and product assessments throughout the software development life cycle.

P.2 APPLICABILITY

This procedure applies to software and firmware created and acquired by or for NASA, including Government off-the-shelf (GOTS) software, modified off-the-shelf (MOTS) software, and commercial off-the-shelf (COTS) software when included in a NASA system. NASA systems include test beds, ground support systems, flight systems, and software research projects that support or perform our scientific missions.

P.3 AUTHORITY

This procedure adheres to the NASA Software Assurance Standard for planning and performing the process and product quality assurance activities.

NASA-STD-8739.8, NASA Software Assurance Standard
NPD 2820.1, NASA Software Policies
GPG 7120.2, Project Management

P.4 REFERENCES

- a. NPD 7120.4, NASA Program/Project Management
- b. NPG 7120.5, NASA Program and Project Management Processes and Requirements
- c. GPG 7120.4, Risk Management
- d. GPG 8700.4, Integrated Independent Reviews

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- e. GPG 8700.6, Engineering Peer Reviews
- f. 300-PG-7120.2.1, Mission Assurance Guidelines (MAG) Implementation
- g. 300-PG-7120.2.2, Mission Assurance Guidelines (MAG) for Tailoring to the Needs of GSFC Projects
- h. 303-PG-1060.1.1, Systems Assurance Manager Reporting
- i. IEEE 610.12, IEEE Standard Glossary of Software Engineering Terminology
- j. IEEE STD 730-2002, IEEE Standard for Software Quality Assurance Plans
- k. SMAP-GB-A201, Software Assurance Guidebook
- l. SMAP-GB-A301, Software Quality Assurance Audits Guidebook
- m. GSFC Software Assurance Web Site: <http://sw-assurance.gsfc.nasa.gov>
- n. 303-WI-7120.1.1, Software Quality Reporting Process
- o. 303-WI-7120.1.2, Software Quality Assessment Process

P.5 CANCELLATION

None

P.6 SAFETY

Not applicable

P.7 TRAINING

Software Quality personnel shall have fundamental knowledge in the following areas through prior experience, training, or certification in methodologies, processes, and standards. The Software Assurance Lead for the Assurance Management Office strongly recommends that all software quality personnel, including systems assurance managers, take those SOLAR (Site for On-Line Learning and Resources) courses marked below with ☒ symbol.

- a. Audits and Reviews ☒
- b. Risk Management Overview ☒
- c. Software Assurance ☒

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- d. Configuration Management
- e. ISO 9001 Introduction
- f. Project Management
- g. SEI Capability Maturity Model Integration (CMMI)
- h. Software Engineering
- i. Verification and Validation

P.8 RECORDS

Record Title	Record Custodian	Retention
SQ Assessment Report	Software Quality Personnel	* <u>NRRS 8/36.5C1</u> – Handle as permanent pending retention approval
Completed Checklists and assessment artifacts	Software Quality Personnel	* <u>NRRS 8/36.5C1</u> – Handle as permanent pending retention approval
SQ Reporting Form (completed)	Code 303, Software Assurance Lead	* <u>NRRS 8/36.5C1</u> – Handle as permanent pending retention approval

*NRRS – NASA Record Retention Schedules ([NPG 1441.1](#))

SQ personnel shall maintain records that document assessments performed on their project. Maintaining records provides objective evidence and traceability of assessments performed throughout the software life cycle. There are two types of records: Hardcopy and Electronic. SQ shall maintain electronic or hard copies of all assessment reports and findings. SQ folders shall contain the assessment work products such as completed checklists, supporting objective evidence, notes, etc. An SQ Tracking Repository or spreadsheet shall be maintained to track findings and observations.

P.9 METRICS

The Software Assurance (SA) Lead shall monitor, analyze, and control the process and product software quality assurance activities in OSSMA based on metrics gathered across GSFC projects. Potential process improvement or corrective action may be applied in areas such as resources assigned to projects, process and/or product assessments planned, and/or training provided to SQ personnel.

Software Quality Program Metrics that will be generated by the SA Lead include:

- a. Number of GSFC projects developing software products and/or systems

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- b. Level of SQ personnel support across GSFC projects
- c. Number of Projects with approved Software Assurance Plans

SQ personnel are responsible for reporting project level metrics per the SQ Reporting Process work instruction, 303-WI-7120.1.1

P.10 DEFINITIONS

- a. Audit – An independent examination of a work product or set of work products to assess compliance with specifications, standards, contractual agreements, or other criteria. [IEEE 610.12]
- b. Configuration Management (CM) – A discipline applying technical and administrative direction and surveillance to identify and document the functional and physical characteristics of a configuration item, control changes to those characteristics, record and report change processing and implementation status, and verify compliance with specified requirements. [IEEE 610.12]
- c. Engineering Peer Review (EPR) – A focused, in-depth technical review that supports the evolving design and development of a product subsystem or discipline area [GPG 8700.6]. The purpose of an EPR is to add value and reduce risk through expert knowledge infusion, confirmation of approach, and specific recommendations. An EPR provides a penetrating examination of design, analysis, integration, test and operational details, drawings, processes and data.
- d. Finding – Non-compliance to a requirement, procedure, standard, or specification.
- e. Integrated Independent Review (IIR) – One of a series of system-level reviews conducted at critical project/product milestones in accordance with GPG 8700.4. IIRs build upon the results of a robust set of engineering peer reviews. IIR examples include System Concept review (SCR), Critical Design Review (CDR), and Mission Operations Review (MOR).
- f. Observation - A statement of fact (positive or negative) based on objective evidence.
- g. Process Assessment – A systematic examination to determine whether a software process is being performed in accordance with documented plans, procedures, etc.
- h. Product Assessment – A systematic examination to determine whether a software product meets specified requirements and standards.
- i. Product Design Lead (PDL) – The manager or leader with overall responsibility for managing the design activity, managing the technical and organizational interfaces identified during design planning, and where required, forming and leading the Product Design Team (PDT). The term refers to flight project managers, principal investigators, mission managers, instrument managers, software managers, lead engineers, etc.
- j. Safety Critical Software – Software that resides in a safety-critical system that is a potential hazard cause or contributor, supports a hazard control or mitigation, controls safety-critical functions, or detects and reports

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1) fault trends that indicate a potential hazard and /or 2) failures which lead to a hazardous condition.

Analysis of the system should consider software that processes hazardous commands or data, is required to put or keep the system in a safe state, provides information upon which a safety decision is made, is part of a safety subsystem, or that can adversely affect system safety by its failure or anomalous behavior.

- k. Software Assurance (SA) – The planned and systematic set of activities that ensure that software life cycle processes and products conform to requirements, standards, and procedures. [IEEE 610.12] For NASA this includes the disciplines of Software Quality (SQ), Software Safety, Software Reliability, Software Verification and Validation (V&V), and Independent Verification and Validation (IV&V).
- l. Software Quality (SQ) – The discipline of software quality is a planned and systematic set of activities to ensure quality is built into the software. It consists of software quality assurance, software quality control, and software quality engineering.
- m. Software Quality Assurance (SQA) - The function of software quality that assures that the standards, processes, and procedures are appropriate for the project and are correctly implemented.
- n. Software Quality Control – The function of software quality that checks that the project follows its standards, processes, and procedures, and that the project produces the required internal and external (deliverable) products.
- o. Software Quality Engineering – The function of software quality that assures that quality is built into the software by performing analyses, trade studies, and investigations on the requirements, design, code, and verification processes and results to assure that reliability, maintainability, and other quality factors are met.
- p. Software Quality Personnel - Personnel responsible for providing SQ support to the Systems Assurance Manager. This includes software quality engineers, Defense Contract Management Agency (DCMA) specialists, or support provided under the Supplier Assurance Contract (SAC). Note: The Systems Assurance Manager may also perform the duties of a software quality person.
- q. Software Requirements Traceability Matrix (SRTM) – A tool developed and maintained by software engineering that traces software requirements back to system requirements and forward to design, code, and test.
- r. Systems Assurance Manager (SAM) – Code 300 personnel responsible for supporting the PDL in the coordination of the definition and implementation of a Project Systems Safety and Mission Assurance Program (SSMAP).
- s. Validation – Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.
- t. Verification - Confirmation by examination and provision of objective evidence that specified requirements have been fulfilled.

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PROCEDURES

1. OVERVIEW

Software Quality (SQ) is defined as a planned and systematic approach for evaluating the quality of and adherence to software product standards, processes, and procedures. It entails reviewing all software development products and related processes to ensure that they meet a predefined set of requirements, standards, and procedures. SQ shall be an integral part of the software development activities, beginning in the formulation phase of the project and continuing through all phases of the project (i.e., concept, requirements, design, implementation, verification, validation, and operation and maintenance).

2. ROLES and RESPONSIBILITIES

Software Quality (SQ) is part of the larger software assurance (SA) program, which is ultimately part of the overall mission assurance program and as such, shall be developed and implemented in conjunction with the mission assurance program. The Systems Assurance Manager (SAM) is responsible for the overall mission assurance program and ensuring that SA is established and fully implemented. This includes defining SA requirements and requesting adequate resources for performing process and product assessments throughout the development life cycle.

Beginning in the formulation phase, the SAM shall develop the Mission Assurance Requirements (MAR) for the project using the GSFC Mission Assurance Guidelines (MAG), 300-PG-7120.2.2. The MAR shall identify all software assurance requirements, including any required software assurance processes and products for the mission. In response to the MAR and the developer's Software Management Plan (SMP), the SAM shall develop a Software Quality Assurance Plan (SQAP) that identifies and details the software assurance activities that will be performed throughout the entire software life cycle. Within the GSFC community and for the purposes of this document, the SQAP is also referred to as the Software Assurance Plan (SAP). NOTE: For the purpose of this procedure, the SAM develops an SAP for the project/mission from the acquirer perspective. The developer, also known as the provider, is responsible for developing an SAP from the developer's perspective.

3. REPORTING

The Systems Assurance Manager (SAM), as well as software quality personnel, maintains a level of independence from the project and the developer(s). Software quality personnel are matrixed to a project and provide Project Management with visibility into the processes and quality of the product. In addition to the required Office of Systems Safety and Mission Assurance (OSSMA) weekly and monthly reporting deliverables as stated in 303-PG-1060.1.1, the SAM is responsible for documenting and reporting software quality assessments, assessment results, issues, and lessons learned to the project and appropriate process and product owners (i.e., stakeholders), as stated in the SQ Reporting Process work instruction.

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4. DEVELOPING the SOFTWARE ASSURANCE PLAN

The project Software Assurance Plan (SAP) is developed in the early stages of, and in parallel with, the overall project planning effort. The SAP provides a foundation for implementing an effective SA program and defines the approach that will be used by the SAM and SQ personnel to monitor and assess software development processes and products. The SAP shall be reviewed and approved by project management. The format of the SAP shall follow the NASA Software Assurance Standard and IEEE STD 730-2002, the IEEE Standard for Software Quality Assurance Plans.

The SAP shall be developed in relationship to the Software Management Plan (SMP) and/or other developer deliverables. The SAP shall identify software quality activities (i.e., process and product assessments) that shall be performed throughout the software development life cycle. In addition, the SAP shall identify the interdependencies with other disciplines (e.g., configuration management, risk management, test management, and lessons learned) and the SQ metrics that will be collected, analyzed, and reported.

Sample software assurance plans, checklists, and reports can be found on GSFC's Software Assurance web site, <http://sw-assurance.gsfc.nasa.gov>, and a link is available from the Virtual Office of Systems Safety and Mission Assurance (VOSSMA) web site.

Table 4.0-1, SQ Activities across the Software Development Phases, is an "At-A-Glance" reference for those SQ activities that are to be performed during each development phase. This table should be used as a planning tool to determine the activities and resources that will be needed to implement the SAP for the project. Tailoring is acceptable commensurate with the scope of the development effort, software size, complexity, criticality, and level of risk associated with the software system(s). **However, some level of SQ is required for all GSFC missions and the presence of IV&V does not preclude the requirements for SQ.**

Reference the NASA Software Assurance Standard for guidelines on Software Quality tailoring.

Table 4.0-1 SQ Activities across the Software Development Phases

Software Development Phases

SQ Activities	Concept	Requirements	Design	Implementation	Integration & Test (Verification)	Acceptance Test (Validation)	Operations & Maintenance	
	Reviews	<ul style="list-style-type: none">Assess System Concept Review (SCR)Review Lessons Learned (LL)	<ul style="list-style-type: none">Assess Software Specification Review (SSR)Capture/Review LL	<ul style="list-style-type: none">Assess preliminary and critical design reviews (i.e., PDR and CDR)Assess peer reviewsCapture/Review LL	<ul style="list-style-type: none">Assess peer reviews (e.g., code walkthroughs or inspections)Capture/Review LL	<ul style="list-style-type: none">Witness test executionAssess Test Readiness Review (TRR)Capture/Review LL	<ul style="list-style-type: none">Witness test executionAssess AR or ORRAssess MOR and FORCapture/Review LL	<ul style="list-style-type: none">Assess software enhancement build reviewsCapture/Review LL
	Software Deliverables	<ul style="list-style-type: none">Develop Software Quality (SQ) task and resource allocation forecastDevelop SW assurance requirements for SOW/MARAssess Quality Manual and Quality Management SystemAssess System Requirements Specification	<ul style="list-style-type: none">Assess Software Management Plan (SMP)Assess Software Requirements Spec's (SRSs) and ICD'sAssess/Approve SA Plan(s)Assess S/W requirements traceability matrix (SRTM)	<ul style="list-style-type: none">Assess Software Design documentationAssess initial development records (e.g., development folders)Assess Test Plans and proceduresAssess updates to SRTM and allocation to S/W components and design	<ul style="list-style-type: none">Assess code for compliance to standardsAssess development recordsAssess final Test Plans and proceduresAssess updates to SRTMAssess preliminary User's Guides	<ul style="list-style-type: none">Assess development recordsAssess Test Reports and test artifactsAssess/verify SRTMAssess final User's Guides	<ul style="list-style-type: none">Assess development recordsAssess Test Reports and test artifactsAssess/verify SRTMAssess ADP/VDDsAssess/Approve Software Maintenance Plan	<ul style="list-style-type: none">Assess updated software documentationReview SA Plan(s) to address O&M phase changes
Configuration Management		<ul style="list-style-type: none">Assess Configuration Management Plan (CMP)Assess CMP complianceParticipate in CCB	<ul style="list-style-type: none">Assess CMP complianceParticipate in CCB	<ul style="list-style-type: none">Assess CMP complianceParticipate in CCB	<ul style="list-style-type: none">Assess CMP complianceParticipate in CCB	<ul style="list-style-type: none">Assess CMP complianceAssess FCA and PCA artifactsParticipate in CCB	<ul style="list-style-type: none">Assess CMP complianceReview operational baselineParticipate in CCB	

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	Concept	Requirements	Design	Implementation	Integration & Test (Verification)	Acceptance Test (Validation)	Operations & Maintenance
Software Problem Reporting (SPR) and Corrective Action (CA)		<ul style="list-style-type: none"> Review and track action items Assess Software Problem Reporting (SPR) system 	<ul style="list-style-type: none"> Review and track action items 	<ul style="list-style-type: none"> Assess, analyze & trend SPRs Review and track action items 	<ul style="list-style-type: none"> Assess, analyze & trend SPRs Review and track action items 	<ul style="list-style-type: none"> Assess, analyze & trend SPRs Review and track action items 	<ul style="list-style-type: none"> Assess, analyze & trend SPRs Review and track action items
Risk Management	<ul style="list-style-type: none"> Assess Project's Continuous Risk Mgmt Approach Assess/Approve Risk Mgmt Plan 	<ul style="list-style-type: none"> Identify, review, and assess software related risks 	<ul style="list-style-type: none"> Identify, review, and assess software related risks 	<ul style="list-style-type: none"> Identify, review, and assess software related risks 	<ul style="list-style-type: none"> Identify, review, and assess software related risks 	<ul style="list-style-type: none"> Identify, review, and assess software related risks 	<ul style="list-style-type: none"> Identify, review, and assess software related risks
IV&V		<ul style="list-style-type: none"> Review IV&V Memorandum Of Agreement (MOA), project plan(s), and technical issues (i.e., TIMs) 	<ul style="list-style-type: none"> Review IV&V monthly reports and TIMs 	<ul style="list-style-type: none"> Review IV&V monthly reports and TIMs 	<ul style="list-style-type: none"> Review IV&V monthly reports and TIMs 	<ul style="list-style-type: none"> Review IV&V monthly reports and TIMs 	<ul style="list-style-type: none"> Review IV&V monthly reports and TIMs

All acronyms are defined within the content of Section 4.0

Key Terms Used: Participate: to be a contributing member with defined roles and responsibilities
Perform: to lead or conduct a prescribed activity
Assess: to evaluate processes/products and provide assessment results and recommendations
Review: to extract for informational purposes and use as potential input into SQ activity planning

The above table is a continuation of Table 4.0-1 SQ Activities across the Software Development Phases

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4.1 Overview of Software Development Activities

The following overview provides a high level description for each of the traditional software development phases with emphasis on SQ activities. The use of phases to describe SQ activities is applicable to any software development methodology or life cycle model.

4.1.1 System Concept Phase

During the system concept phase, the software concept is developed, the feasibility of the software system is evaluated, and the acquisition strategy is developed. The SAM develops a task order and secures resources to perform software quality. If the software system is to be acquired, a procurement package, including software assurance requirements, is prepared and a contract is awarded. After contract award, SQ personnel assess the developer's quality management system to assure that standards and procedures are in place as required by the mission assurance requirements. This phase ends with a System Concept Review (SCR).

4.1.2 Software Requirements Phase

During the software requirements phase, the developer analyzes the system requirements to generate the software requirements. Test planning is begun, with a method for verifying each requirement identified and included in a preliminary test plan. Software requirements are mapped back to system requirements and safety critical software requirements are uniquely identified and included in a preliminary software requirements traceability matrix. Methods, standards, and procedures are detailed and put in place. This phase ends with a requirements review, at which time the requirements are agreed to between the acquirer and the developer and placed under configuration management control.

SQ personnel reviews and assesses each of the developer's documents and the maturity of the processes, plans, and procedures that have been established. Key software deliverables during this phase include the developer's final Software Management Plan (SMP), Software Requirements Specification, Software Assurance Plan (SAP), and Software Configuration Management Plan (CMP). These documents are typically separate documents, but may be found in the SMP for smaller projects.

If IV&V is warranted, the SAM and/or SQ personnel establish a working relationship with IV&V that fosters open communication and exchange of software assurance data.

4.1.3 Software Design Phase

The software system is typically designed in two phases. The architectural design (or preliminary design) results in a high level design of the system, where requirements are fully allocated to software components. During the detailed design phase, the architectural design is expanded to the lowest level and the detailed design is baselined at the conclusion of the critical design review (CDR). Interface control documents are completed and test plans revised and all design documents are placed under configuration control.

During the design phases, SQ focuses on the developer's progress and documentation of the software design (e.g., attends design reviews/walkthroughs). If software development folders (or other similar documentation) are used, they should be initiated early in the design phase and frequently assessed for accuracy and

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compliance to required content. SQ also assures that all requirements have been allocated to software components and that configuration management mechanisms are in place and effectively controlling the requirements, software design, software documentation, and action items.

4.1.4 Software Implementation Phase

During the implementation phase, the software is coded and unit tested. This is a critical phase in the software development life cycle whereby compliance to standards and procedures is imperative. SQ provides management visibility into the development processes and quality of the product through participation in code walkthroughs or inspections and assessments of configuration control processes, software development records, and updates to the software requirements traceability matrix. SQ also analyzes and trends software problem reports, monitors and tracks action items from system reviews and engineering peer reviews, and monitors risks. At the end of the phase, required products should be ready for delivery, subject to modification during integration and test. Final test plans and procedures are completed, along with preliminary user's guides, and reviewed by SQ.

4.1.5 Software Integration and Test Phase

The objectives of the integration and test phase are to integrate the software units into a completed subsystem or system, discover and correct any nonconformances or software problem reports, and demonstrate that the software system meets its requirements. A test readiness review (TRR) concludes this phase, at which time the developer provides evidence that the software system is ready for acceptance testing. SQ assesses the development records, test reports, and test artifacts to substantiate the readiness of the software for final delivery. In addition, SQ continues to monitor and assess the developer's configuration management system, to analyze and trend software problem reports, and to review the accuracy of the requirements traceability matrix. Final user's guides should be completed prior to acceptance test and reviewed by SQ.

4.1.6 Software Acceptance Test Phase

During the acceptance test phase, formal acceptance procedures are executed to demonstrate that the system meets customer requirements and that the right product was developed. SQ continues to focus on test activities and documentation, configuration management, software and hardware baseline management, software problem reports, and overall readiness of the system. This phase concludes with an acceptance review (AR).

4.1.7 Operation and Maintenance Phase

During this phase, the software is baselined and used in its intended environment. Software corrections and modifications are made to sustain/enhance its operational capabilities and to upgrade its capacity to support its users. SQ continues to assess updated software documentation, changes to the operational baseline, configuration management controls, and the software problem reporting system. The level of SQ should be commensurate with the extent and criticality of changes being made to the software. When long term sustaining engineering is required, the acquirer should ensure that a yearly assessment is performed to assure a stable and mature software system. The SAP should also be updated to reflect the required Operation and Maintenance activities.

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4.2 SQ Product Assessments

SQ personnel shall conduct all product assessments in accordance with the Software Quality Assessment Process work instruction, 303-WI-7120.1.2. SQ assessments of software development products are based on the products defined in the developer's Software Management Plan (SMP). The SMP deliverables, contractual deliverables, and the identified reviews form the basis for the SQ assessment criteria.

Table 4.2-1 below summarizes software product assessments typically performed during the development and maintenance of software. A brief description is provided for each software product along with the title of the SQ work instructions to be used for performing the assessment. The objectives for each product assessment are provided in Sections 4.2.1 through 4.2.5.

Table 4.2-1 Software Product Assessments by SQ

#	Product Types	Description of Product	SQ Work Instruction
1	<u>System/Subsystem Reviews:</u> <ul style="list-style-type: none"> • System Concept Review (SCR) • Software Specification Review (SSR) • Preliminary Design Review (PDR) • Critical Design Review (CDR) • Test Readiness Review (TRR) • Acceptance Review (AR) • Operations Readiness Review (ORR) • Mission Operations Review (MOR) • Flight Operations Review (FOR) 	Series of system-level or subsystem reviews conducted at critical project/product milestones.	<ul style="list-style-type: none"> • SQ Systems Review Assessment • SQ Reporting Process
2	Engineering Peer Reviews	Focused, in-depth technical reviews of a product subsystem or component (e.g., design walkthrough or code walkthrough).	<ul style="list-style-type: none"> • Engineering Peer Review Assessment • SQ Reporting Process

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#	Product Types	Description of Product	SQ Work Instruction
3	<u>Document Reviews:</u> <ul style="list-style-type: none"> • Quality Manual (QM) • Software Assurance Plan (SAP) • Software Management Plan (SMP) • Configuration Management Plan (CMP) • Software Requirements Specification (SRS) • Risk Management Plan (RMP) • Test Plans (Verification) • Software Maintenance Plan (SWMP) • Software User Guide (SUG) • Interface Control Document (ICD's) • Test Reports and Artifacts • Software Acceptance Data Packages (ADP) • Software Requirements Traceability Matrix (SRTM) 	Documents capturing the requirements, design, test, maintenance, methodologies, and approaches for managing the software development effort.	<ul style="list-style-type: none"> • SQ Documentation Assessment • SQ Reporting Process
4	Software Development Records (e.g., folders /logs)	Software development records that may contain, but are not limited to, software design data, code, test results, risks, etc.	<ul style="list-style-type: none"> • Software Development Records Assessment • SQ Reporting Process
5	Software Configuration Management (SCM)	<ul style="list-style-type: none"> • Work products from configuration control boards, baseline audit reports, status accounting reports, etc. 	<ul style="list-style-type: none"> • Software Configuration Management (SCM) Assessment • SQ Reporting Process

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4.2.1 System/Subsystem Reviews

SQ shall assess the supporting data packages from system level\software subsystem reviews to assure that:

- a. Review packages are being developed according to the specified criteria as required by the Systems Review Office
- b. Content is complete, accurate and of sufficient level of detail
- c. Requests for Action are captured, reviewed, and tracked to closure

4.2.2 Engineering Peer Reviews

SQ shall assess Engineering Peer Reviews (EPR) data packages to assure that:

- a. Review packages are being developed according to the Systems Management Office (Code 306) requirements in GPG 8700.6, Engineering Peer Reviews
- b. Content is complete, accurate, and of sufficient level of detail
- c. Requests for Action are captured, reviewed, and tracked to closure

4.2.3 Document Reviews

SQ shall conduct product assessments on documents used to plan, develop, test, and maintain software.

Software documents are assessed to ensure that:

- a. Technical documents are being developed in accordance with contractual documents and specified standards
- b. Content within documents are a complete and accurate representation of the specified standard or required format and will satisfy software requirements
- c. Level of detail is sufficient and consistent throughout
- d. Requirements traceability between formal technical documents exists
- e. Proper document versioning appears on document

4.2.4 Software Development Records (e.g., folders /logs)

SQ shall assess software development records (e.g., software development folders) to assure that software work products developed during the life cycle phases are being maintained and that changes are recorded promptly.

4.2.5 Software Configuration Management

SQ shall assure that software configuration management (SCM) products are generated per the CMP or the SMP. SCM products are assessed to assure product integrity throughout the life cycle.

The SQ assessment shall include, but is not limited to, configuration items, configuration baselines, change control records, and configuration audit records.

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4.3 SQ Process Assessments

SQ personnel shall conduct all process assessments in accordance with the Software Quality Assessment Process work instruction, 303-WI-7120.1.2. SQ assessments of the software development processes are based on the processes defined in the developer's Software Management Plan (SMP). The SMP and its identified project procedures form the basis for the SQ assessment criteria.

Table 4.3-1 below summarizes software process evaluations typically performed during the development and maintenance of software. A brief description is provided for each software process, along with the title of the SQ work instructions to be used for performing the assessment. The objectives for each process assessment are provided in Sections 4.3.1 through 4.3.8.

Table 4.3-1 Software Processes Evaluated by SQ

#	Process Types	SQ Work Instruction
1	<u>System/Subsystem Reviews:</u> <ul style="list-style-type: none"> • System Concept Review (SCR) • Software Specification Review (SSR) • Preliminary Design Review (PDR) • Critical Design Review (CDR) • Test Readiness Review (TRR) • Acceptance Review (AR) • Operations Readiness Review (ORR) • Mission Operations Review (MOR) • Flight Operations Review (FOR) 	<ul style="list-style-type: none"> • SQ Systems Review Assessment • SQ Reporting Process
2	Engineering Peer Reviews	<ul style="list-style-type: none"> • Engineering Peer Review Assessment <p>SQ Reporting Process</p>
3	Requirements Management	<ul style="list-style-type: none"> • Software Requirements Management Assessment • SQ Reporting Process
4	Software Configuration Management (SCM)	<ul style="list-style-type: none"> • Software Configuration Management (SCM) Assessment • SQ Reporting Process

#	Process Types	SQ Work Instruction
5	Test Management	<ul style="list-style-type: none"> • SQ Test Management Assessment • SQ Reporting Process
6	Software Problem Reporting and Corrective Action	<ul style="list-style-type: none"> • Software Problem Reporting and Corrective Action Assessment • SQ Reporting Process
7	Risk Management	<ul style="list-style-type: none"> • SQ Risk Management Assessment • SQ Reporting Process
8	Lessons Learned	<ul style="list-style-type: none"> • SQ Lessons Learned Assessment • SQ Reporting Process

4.3.1 System/Subsystem Reviews

SQ shall assess the process used to conduct reviews to determine if technical and systems management experts are in attendance, correct information is presented, entry and exit criteria are met, appropriate documents are identified for update, and that a system is in place to capture, review and track action items to closure.

4.3.2 Engineering Peer Reviews

SQ shall assess the process used to conduct engineering peer reviews to determine if the appropriate technical engineers are in attendance, correct information is presented, appropriate documents are identified for update, and that a system is in place to capture, review and track action items to closure.

4.3.3 Requirements Management

SQ shall assess the processes for requirements management as described in the developer's SMP or CMP.

SQ shall assure that:

- Processes are in place for managing and maintaining the requirements baseline throughout the software development life cycle, including requirements identified as software safety critical
- A Software Requirements Traceability Matrix has been developed and routinely updated to reflect changes in status
- Requirements changes are communicated across the project teams

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4.3.4 Software Configuration Management (SCM)

SQ shall assure that SCM processes are implemented per the CMP or the SMP. The SQ assessment shall include SCM change control, software code management, software license management, configuration audits, baseline management, etc.

SQ shall assure that the SCM processes address the following:

- a. Configuration Identification
- b. Configuration Control
- c. Configuration Status Accounting
- d. Configuration Audits and Reviews
- e. Interface Control
- f. Subcontractor/vendor control (if applicable)

4.3.5 Test Management

SQ shall assure that the test management processes are being implemented per the SMP and /or Test Plan(s). This includes all types of testing of software system components as described in the test plan, specifically during integration testing (verification) and acceptance testing (validation). SQ shall monitor testing efforts to assure that test schedules are adhered to and maintained to reflect an accurate progression of the testing activities. Test monitoring may be scheduled or performed at random. The purpose of the test management assessment is to assure that:

- a. Tests are planned and documented
- b. Tests are conducted using approved test procedures and appropriate test tools
- c. CM processes are implemented to maintain the test environment integrity
- d. Assumptions, constraints, and results are accurately recorded
- e. Anomalies are identified, documented, addressed, and tracked to closure
- f. Requirements are satisfied

4.3.6 Software Problem Reporting and Corrective Action

SQ shall assess the software change control process to assure it is being implemented per the CMP or SMP. SQ personnel shall assess change control as it relates to those changes identified as necessary using discrepancy reports (DRs). DRs identify changes that have been requested due to deficiencies found during testing, installation, or operations. DRs are evaluated as to their criticality to the system operation.

4.3.7 Risk Management

SQ shall assess the project's risk management process against the documented risk management plan and GPG 7120.4.

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4.3.8 Lessons Learned

SQ shall assess the project's application of lessons learned to assure that project personnel capture, review, identify, and implement process improvements throughout the development life cycle. For example, the Program/Project Manager shall report the extent to which he or she applied lessons learned at each major milestone. Reference NPG 7120.5 for specific requirements.

5. SQ PROCESS FLOW

The table below describes the steps that SQ personnel shall follow from project initiation through project completion. The table summarizes the key tasks and does not show the numerous lower level steps that are required.

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Table 5.0-1 Software Quality Process Flow

Step	Flowchart Symbol	Flowchart Symbol Description	Owner	Action
1	Oval	Begin/End	SQ	Begin SQ Program
2.	Hexagon	Joint Process	SQ	SQ, Software Development and Software Configuration Management develop their respective plans and coordinate them for consistency (e.g., SMP, CMP, SAP, RMP, etc)
3.	Square	Process	Project Mgmt, and OSSMA Mgmt	SA Plan is reviewed and approved
4.	Square	Process	SQ	Perform SQ activities (e.g., scope assessment, conduct process and product assessments, etc...)
5.	Diamond	Decision	SQ	Did assessment yield the need for a finding? If no, proceed to step 7, If yes, proceed to step 6.
6.	Square	Process	SQ	Initiate action request and track deficiencies to closure
7.	Square	Process	SQ	Prepare assessment report and distribute to project management and OSSMA. Maintain SQ record.
8.	Document	Output	SQ	SQ Assessment Report
9.	Cylinder	Database	SQ	Update SQ database
10.	Rectangle	Process	SQ	Perform metrics analysis, perform trend analysis, Identify lessons learned and/or process improvements
11.	Diamond	Decision	SQ	Is this the end of Project? If Yes, go to 13. If No, go to 12.
12.	Diamond	Decision	SQ	Are there updates to the SAP? If Yes, go to Step 2. If No, go to Step 4.
13.	Oval	End Project	SQ	End of SQ Program

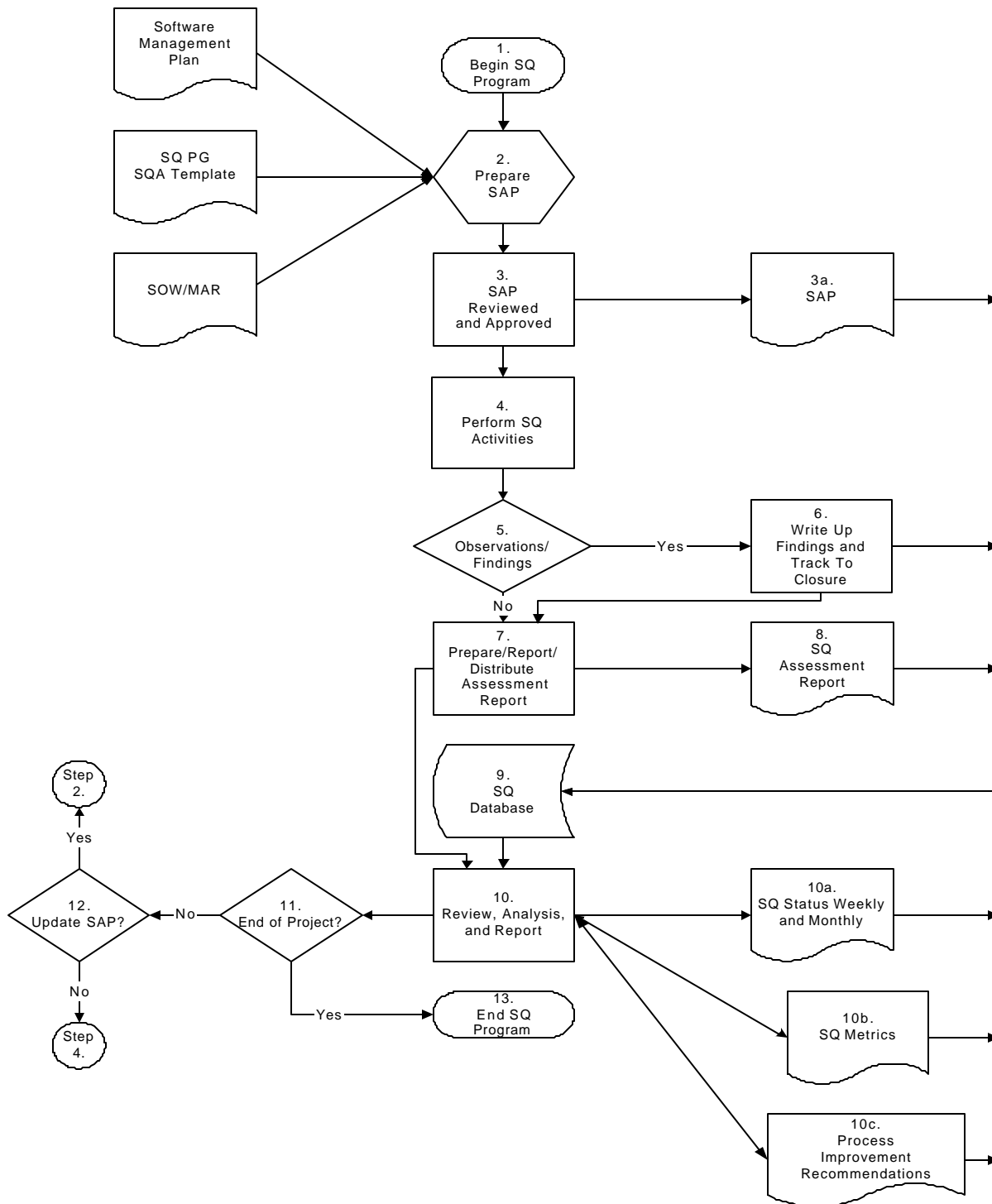


Figure 5.0-1 Software Quality Flow Diagram

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CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	11/17/2003	Initial Release
A	7/27/2004	Modified title of PG, added configuration control number to the NASA Software Policies NPD, added 3 new references to P.5, modified recommended training in P.7, modified definitions for “finding” and “observation”, added an SQ Reporting Form to P.8, deleted option to include the SAP in the Project’s Surveillance Plan, provided updates to Table 4.0-1, added references to the Software Quality Assessment Process 303-WI-7120.1.1 in Sections 4.2 and 4.3, deleted the Software Safety Plan as a product in Table 4.2-1, and updated naming convention to several software quality work instructions in Tables 4.2-1 and 4.3-1.

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